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PATENT & TRADEMARK OFFICE

Attorney Docket No. ALCOA 97-2301 (093683-010100)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventors : Roberto J. Rioja et al.
Serial No. : 10/678,290
Filed : October 3, 2003
For : ALUMINUM-COPPER-MAGNESIUM ALLOYS HAVING ANCILLARY ADDITIONS OF LITHIUM
Examiner : Janell Combs Morillo
Art Unit : 1742

MAIL STOP: Amendment
Hon. Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

DECLARATION OF ROBERTO J. RIOJA PURSUANT TO 37 C.F.R. § 1.132

Sir:

Roberto J. Rioja, declares that:

1. I received a Doctor of Philosophy degree in 1979 and a Master of Science degree in 1977 in Metallurgy and Materials Science from Carnegie-Mellon University, and a Bachelor of Science in Metallurgical Engineering from the National Polytechnic Institute in Mexico in 1975. I have been employed by Alcoa, Inc., the assignee of the application, since April 1983. I am currently Technical Program Manager, responsible for Alcoa Al-Li used in aerospace, space and transportation vehicles. I submit this Declaration in support of the patentability of the claims in U.S. Application Serial No. 10/678,290.

2. I am one of the joint inventors and am fully familiar with U.S. Application Serial No. 10/678,290 and its file prosecution history. See Attachment A. I have read and am familiar with the initial prosecution of the '290 Application, the Office Action of August 8, 2006 and the prior art cited by the Examiner.

Unexpected Results

3. The alloys described and claimed in the '290 Application are aluminum alloys having ancillary additions of lithium. My co-inventors and I have discovered that fracture toughness of aluminum-copper-magnesium may be significantly improved by the addition low levels of lithium. The lithium additions of the present invention yield improved toughness at higher strength levels contrary to the teachings of the prior art. Accordingly, there is an increase in fracture toughness with an increase in strength. This is an unexpected result because generally lithium additions in excess of that claimed is well known to decrease fracture toughness in conventional aluminum-copper-magnesium-lithium alloys. See paragraph [0071].

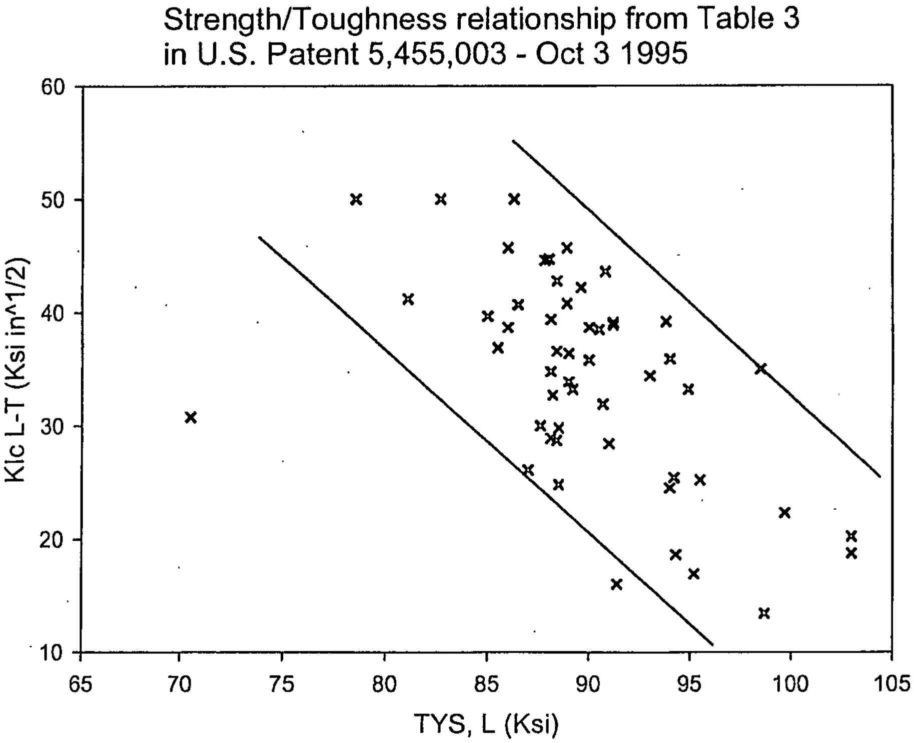
4. In general, it is known in the art that adding lithium to conventional aluminum-copper-magnesium-lithium alloys result in higher strength but lower fracture toughness. This inverse yield strength to toughness ratio of aluminum-copper-magnesium alloys is exhibited in Staley J. T., "Microstructure and Toughness of High Strength Aluminum Alloys," *Properties Related to Fracture Toughness*, ASTM STP 605, 1976, pp. 71-103. See Attachment B.

5. My co inventors and I have analyzed the data set forth in Pickens, U.S. Patent No. 5,455,003 and found the alloys to exhibit this well known inverse yield strength to toughness ratio. See Attachment C. Pickens discloses that the highest strength attained with Li levels of from about 1.05 to about 1.35 weight %. Pickens goes on to disclose that a desirable cryogenic fracture toughness trend is attained and strength levels are very high at copper levels of about 4% and lithium levels of about 1%. He specifically teaches that lowering the levels of copper and lithium below these amounts may still result in a desirable trend, but with lower strengths. See Columns 17-18, lines 63-67 and lines 25-31, respectively.

6. The '290 Application discloses that relatively small amounts of lithium of from about 0.01 to about 0.8 weight % in alloys containing at least 0.6% magnesium have been found to maintain high fracture toughness and strength of the alloys as well as provided increased fatigue crack growth resistance and decreased density. The '290 application also discloses that at lithium levels above the present levels, fracture toughness decreases significantly as is know in the art.

Furthermore, care should be taken in not adding more lithium since exceeding the maximum solubility will lead to lower fracture toughness and low damage tolerances. Lithium additions in amounts of about 1.3 weight percent and above result in the formation of the δ' ("delta prime") phase with composition of Al_3Li. The presence of this phase, Al_3Li, is to be avoided in the alloys of the present invention. See Paragraph [0037]. Thus, the '290 Application discloses adding less lithium to the aluminum-copper-magnesium alloys than in Pickens.

7. I have created a graph that plots Pickens' alloys yield strength versus toughness values from the data reported. Table 3 on Col. 15-18 of Pickens as follows:



8. The Graph shows the inverse relationship between yield strength and toughness disclosed in Pickens. In other words, as the yield strength of Pickens's alloy increases, the toughness of those alloys decrease as all the data point fall within a band showing the increase relationship for the various alloys. Although there are some stray data points, the overall statistical trend shows the inverse relationship between yield strength and toughness in Pickens.

9. FIG. 5 in the '290 application shows that a plot of the fracture toughness and tensile yield strength in comparison with plant typical and minimum fracture toughness and yield strength values for conventional alloy 2524 sheet. This supports the conclusion that the addition of lithium to that aluminum alloy allows maintaining strength and increasing fracture toughness when compared to 2524 alloy sheet and to the fuselage sheet with no addition of lithium and a copper-magnesium, silver alloy with 1.2 weight % of lithium.

10. The alloys claimed in the '290 application achieve the desired needed improvements in that the aluminum-copper-magnesium alloys having ancillary additions of lithium provide improved combinations of fracture toughness and strength over the prior art aluminum-copper-magnesium alloys. The alloys claimed in the '290 application also exhibit improved fatigue crack growth resistance. These allow are particularly useful for aircraft parts that requires a high damage tolerance, such as lower wing components, fuselage components...etc.

The Claims in the '290 Application

11. The '290 Application discloses and claims an aluminum alloy having good damage tolerance and fatigue crack growth resistance. This alloy comprises from about 3 to about 5 weight percent Cu, from grater than 0.6 to about 2 weight percent Mg, from about 0.01 to about 0.8 weight percent Li, up to about 2.0 weight percent Zn, up to about 2.0 weight percent Ag, up to about 1 weight percent of a grain refiner, and the balance aluminum and incidental elements and impurities, wherein the Cu and Mg are present in a controlled amount in the alloy such that they are present in a total amount below a solubility limit of the alloy. Unexpectedly, it was found that when there is a decrease in the Li, the aluminum-copper-magnesium alloys exhibit significantly increase fracture toughness and strength of the alloys as well as provided increased fatigue crack growth resistance and decreased density.

12. The alloy described and claimed in the '029 Application shows improved fracture toughness, strength and fatigue properties compared to Pickens' alloys. See Attachment A.

13. The undersigned declares further that all statements made herein of his own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Roberto J Rioja

Alcoa Center, PA
February 5, 2007

Roberto J. Rioja
02/05/2007

Attachments

Attachment A - U.S. Application Serial No. 10/678,290 to Rioja et al.

Attachment B - Staley J. T., "Microstructure and Toughness of High Strength Aluminum Alloys," *Properties Related to Fracture Toughness*, ASTM STP 605, 1976, pp. 71-103.

Attachment C - U.S. Patent No. 5,455,003 to Pickens et al.